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(54) **An arthropod control composition for plant protection.**

(57) The present invention relates to a non-toxic arthropod control composition applied to foliage for plant protection comprising a Behavior-Interfering Compound (BIC), agricultural oil and/or surface active compounds (emulsifiers) and diluents such as water or an appropriate organic solvent. The BIC phytotoxicity is masked and its efficacy increased by formulating the compound with crop oils (agricultural oils) in the absence or presence of an adjuvant. The BIC is selected from general purpose arthropod repellents, C₁₀-C₂₂ alcohols, C₁₀-C₂₂ carbonyl compounds, C₁₀-C₂₂ carboxylic acids and terpenoids, polybasic carboxylic acids, substituted mono- and polybasic carboxylic acids, esters of the mentioned carboxylic acids.

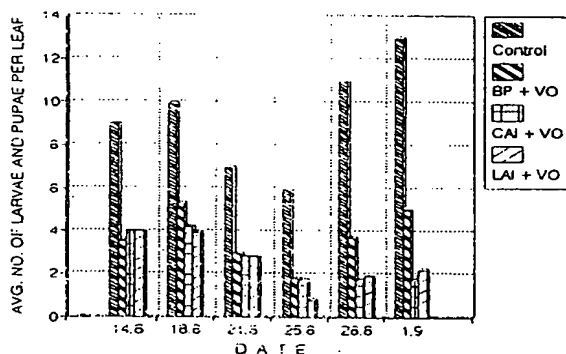


Fig 1. Effect of BIC + VO on field population of TWF (VO=3% cottonseed oil, BP= 1% dibutyl phtalate, CAL=1% cetyl alc., LAI=1% lauryl alc.)

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Field of the Invention

The present invention relates to arthropod control compositions for plant protection. More specifically said invention relates to non-toxic arthropod control composition applied to foliage for plant protection comprising a Behavior-interfering Compound, agricultural oil and/or surface active compounds and diluents.

Background of the Invention

Biocompatible Insect Control-agents (herein called "BICs") - i.e. pest control agents which pose little hazard to humans and to the environment have been known for many years and their number is steadily growing. BIC can act as insect behavioral modifiers (such as feeding and oviposition deterrents, repellents, etc.), hyperactivity inducers, knock down agents, physical barriers or physical poisons [J.J. Kabara (1987), Fatty Acids and Esters as Antimicrobial/insecticidal Agents. In G. Fuller and D. Nees (eds.): Ecology and Metabolism of Plant Lipids. Washington: ACS, pp. 220-238].

BIC are related to many chemical classes such as certain carboxylic acids, alcohols, esters, ethers, amides, terpenoids, limonoids, sulfides and heterocyclic compounds [(D.A. Carlson (1978) Repellents. In: Kirk. Othmer Encyclo. Chem. Technol. pp. 786-805].

Increasingly, BIC are used as alternatives for neurotoxic insecticides mainly for human protection with (DE 3,211,632) and without (Carlson 1978) oils but also for veterinary purposes and to control food and store insects (IL Patent No. 53570).

Many BIC possess properties which are highly desirable also for plant protection, mainly on account of their rapid and safe action. However, most BIC cannot be applied to foliage due to their phytotoxic nature (Kabara 1987). One solution to this problem is to formulate BIC in a way which decreases their phytotoxicity and at the same time preserves or promotes their activity against the target pest.

The team agricultural oils [L.S. Helser and F.W. Plapp (1986) Combinations of Oils and Similar Compounds with Insecticides: Effect on Toxicity and Leaf Residues. South. Entomol.: 75-81] is used rather loosely to describe different mixtures of lipophilic chemicals [such as mineral oils, vegetable (corp) oils (hereinafter called "VO") and silicones], which differ enormously in their on-leaf behavior [D. Veierov, M.J. Berlinger and A. Fenigstein (1988), The Residual Behavior of Fenpropathrin and Chlorpyrifos Applied as Aqueous Emulsions and Oil Solution to Greenhouse Tomato Leaves. Med. Fac. Landbouww, Gent 53:1535-1541]. Vegetable oils (VO) have been used for many years directly for control of weeds, fungi and insects, and as solvents and additives in conventional pesticide formulations.

Oils of various types were found to increase penetration of pesticides into leaf interiors (Veierov 1988). This, in part, explained the enhanced phytotoxicity of herbicides when applied to foliar together with oils.

Many types of VO can retard foliage penetration of pesticides when the two ingredients are properly formulated together. Moreover, the pesticide residue is retained above the leaf surface available to the insect and protected from weathering [D. Veierov and M. Rumakom (1991), Optimization of Foliar-applied Formulations for the Control of the Tobacco Whitefly Under Field Condition. Final report to U.S. Agency of International Development: 140].

Brief Description of the Invention

The present invention relates to a non-toxic arthropod control composition applied to foliage for plant protection comprising a Behavior-Interfering Compounds, agricultural oil and/or surface active compounds and diluents. The Behavior-Interfering Compound is any known conventional compound that can interrupt or alter the normal behavioral sequences of the target. The agricultural oil can be a vegetable oil.

Detailed description of the Invention

The present invention relates to a non-toxic arthropod control composition applied to foliage for plant protection comprising a Behavior-Interfering Compounds, agricultural oil and/or surface active compounds (emulsifiers) and diluents (such as water or an appropriate organic solvents).

According to the present invention BICs phytotoxicity is masked and their efficacy is increased by formulating them with crop oils (agricultural oils) in the absence or presence of additional adjuvants.

Crop oils masks BIC phytotoxicity by reducing the contact between the BIC residue and leaf-surface, or by retarding BIC foliar penetration. The efficacy of BIC is promoted due to the action of the oil component as synergist and/or a complementary control measure. The oil component acts also as an extender.

Formulation of BIC with agricultural oil resulted in a very fast and persistent action, which is a prerequisite to control of some of the most serious types of agricultural pests.

Quick action is required to prevent the settling of migration stages of the target pest, and to deter egg deposition and/or virus transmission.

Persistent action guarantees prolonged protection both by repelling migrating stages and by killing the less mobiles ones (such as certain types of larvae).

In summary, BIC functions are: a) To provide fast activity as behavior modifiers, knock-down agents and/or physical barriers. b) To extend the effective duration of the oil residue.

Vegetable oil function: a) To reduce phytotoxicity. b) To synergies, or to provide complementary control activity. c) To extend BIC effective duration.

The BIC is any known conventional compound that can interrupt or alter the normal behavioral sequences of the target. The BIC can be any repellent or deterrent agent, hyperactivity inducer or irritant, narcotic, knock-down agent or physical barrier agent. Examples are C₁₀-C₂₂ alcohols, C₁₀-C₂₂ carbonyl compounds and terpenoids. More specifically the BIC is selected from methyl-nonyl keton, N-butyl acetanilide, N,N-diethyl-3-methylbenzamide (DEET), dibutyl phthalate, dimethyl phthalate, dibutyl succinate, dibutyl adipate, butopyronoxyl (Indalone), butoxypoly (propylene glycol), benzyl benzoate, 2-ethyl-1,3-hexanediol, 2-butyl-2-ethyl-1,3-propanediol, 2-hydroxyethyl n-octyl sulfide, oitronellel, camphor, camphene, terpinen-4-ol, linalool, isoborneol, borneol, isobornyl acetate, bornyl acetate, phytol, β -farnesene, lauryl alcohol, cetyl alcohol, oleyl alcohol, myristic acid, stearic acid.

The agricultural oil according to the present invention can be a vegetable oil. Said vegetable oil can be selected from cottonseed oil, soybean oil, rapeseed oil, castor oil, sunflower oil, groundnut oil, palm oil, safflower oil, coconut oil, sesame oil, corn oil and linseed oil.

The composition according to the present invention can be used against many types of arthropods e.g. sucking arthropods. Said composition can be applied against whiteflies (Aleurodidea) and aphids (Aphidoidiea).

The present invention relates also to a method for protection of plants against arthropod comprising application or spraying of the arthropod control composition defined in claim 1 to the plants leaves.

The invention will be clarified and exemplified by means of the following examples. Said examples are in no way intended to limit the scope of the invention.

Formulation Examples

Example 1.

a) Emulsifiable concentrate (without co-solvent)

6-24 parts of active ingredient 88-70 parts of vegetable oil

6 parts of surfactant (high hlb surfactant such as Tween 80 & Tween 20)

b) Emulsifiable concentrate (including co-solvent)

15 parts of active ingredient

41 parts of vegetable oil

41 parts of aromatic co-solvent (such as xylene)

3 parts of surfactant (preferably high hlb surfactant such as Tween 80 or Tween 20).

c) Emulsifiable concentrate (including co-solvent)

5 parts of active ingredient

16 parts of vegetable oil

78 parts of polar co-solvent (such as ethanol)

1 parts of surfactant (preferably high hlb surfactant such as Tween 80 or Tween 20).

By dilution of such a concentrate with water it is possible to prepare emulsions of the desired concentration which are especially suitable for leaf application.

d) Oil solution (for Ultra Low Volume spray)

1-3 parts of active ingredient

7-9 parts of vegetable oil

0-1 parts of surfactant (preferringly high hlb surfactant such as Tween 80 or Tween 20)

Biological Examples: PHYTOTOXICITY TESTS

Example 2.

- 5 Greenhouse test: The phytotoxicity of BIC + VO emulsions (examples 1a-d) was compared to that of emulsions of the separated components and to untreated controls. The emulsions were sprayed onto potted seedlings of cotton (Acala SJ-2) and tomato (Marmande) at the 4 leaf stage, and to pepper (Wyndal) and cucumber (Beit Alfa) at the 2 leaf stage. Sprays beyond runoff were made with hand-held sprayer at 4-6 psi. Discrete drops sprays (Ultra Low Volume, ULV) were applied with a commercial aerodynamic atomizer (Atomist, Root-Lowell Crop., U.S.A.). To ensure LV-spray uniformity the potted plants were placed individually on a rotating table in front of the sprayer. The treated plants were held under greenhouse at average minimum and maximum temperatures were 15 and 22°C, respectively. Leaf damages were determined twice, 7 and 14 days post treatments. Individual leaves were visually assessed by averaging five samples, each consists of ten potted plants. A rating of 0, 1, 2, 3, 4 indicated <1%, 1-10%, 11-25%, 26-50%, >50% average leaf damage respectively.

For all test plant species, treatments with BIC + VO formulations resulted in significantly lower level of foliar damage than treatment with BIC alone:

		Injury Indices on the Indicated Test Plants				
Chemical ¹	Oil	Cotton	Tomato	Paper	Cucumber	Comments ²
Esters:						
BP	(-)	4	4	4		
BP	(-)	4	4	4		ULV
BP	Cottonseed oil	0	0	0		
BP	Cottonseed oil	0	0	0		ULV
BP	Rapeseed oil	0	0	0		
BP	Castor oil	0	0	0		
BP	Soybean oil	0	0	1		

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		Injury Indices on the Indicated Test Plants					
5	Chemical ¹	Oil	Cotton	Tomato	Paper	Cucumber	Comments ²
	BNBN	(-)	4	4	4		
	BNBN	(-)	4				ULV
	BNBN	Cottonseed oil	0	1	1		
10	BNBN	Cottonseed oil	0				ULV
	BNBN	Rapeseed oil	0	0			
	BNBN	Castor oil	0	1	0		
	BNBN	Soybean oil	1	3	2		
			<u>Carboxylic acids</u>				
15	MAC	(-)	0	2	2	3	
	MAC	Cottonseed oil	0	0	0	0	
	MAC	Cottonseed oil	0	0	0	0	
	MAC	Cottonseed oil	0	0	0	0	Ethanol
	MAC	Cottonseed oil	0	1	0	1	Xylene
20	MAC	Rapeseed oil	0	0	0	0	
	SAC	(-)	0	0	2	2	Xylene
	SAC	Cottonseed oil	0	0	0	0	Xylene
			<u>Fatty alcohols</u>				
25	CA1	(-)	0	1	2	2	
	CA1	Cottonseed oil	0	0	0	0	
	CA1	Rapeseed oil	0	0	0	0	
	CA1	Soybean oil	0	0	0	0	
30	LA1	(-)	3	4	3		
	LA1	Cottonseed oil	0	0	1		
	LA1	Rapeseed oil	0	0	0		
	LA1	Soybean oil	2	3	2		
			<u>Terpenoids</u>				
35	TER. MIX.	(-)	4	4			
	TER. MIX.	Cottonseed oil	0	2			Ethanol
	TER. MIX.	Cottonseed oil	0	1			
40	5\ Miscellaneous						
	Deet	(-)	4				
	Deet	Castor oil	1				
45	MGK-874	(-)	4				
	MGK-874	Castor oil	1				

50

55

Injury Indices on the Indicated
Test Plants

5	Chemical ¹ Oil		Injury Indices on the Indicated Test Plants				Comments ²
			Cotton	Tomato	Paper	Cucumber	
			Oils & Untreated				
	(-)	(-)	0	0	0	0	
	(-)	Cottonseed oil	0	0	0	0	
10	(-)	Rapeseed oil	0	0	0	0	
	(-)	Soybean oil	0	0	0	0	
	(-)	Castor oil	0	0	0	0	

15 1 BNB = Benzyl benzoate, BP = dibutyl phthalate, CAI = cetyl alcohol, Deet (0.2%) = N,N-diethyl-m-toluamide, LAI = lauryl alcohol, MGK-874 (0.2%) = 2-hydroxy-n-octyl sulfide, MAC = myristic Acid, SAC = Stearic acid, TER.MIX = terpenoid mixture consists of Phytol (0.5%) + Linalool (0.25%) + Geraniol (1%) + Carvone (0.25%). BIC concn. = 1% wt/wt, formulated with no co-solvent, if not specified otherwise.

20 2 Ethanol = contains 3% ethanol, LV = low volume spray, Xylene = contains 3% xylene.

25 Example 3.

30 Field test: Commercial cotton (H-23) was sown in regular row width (96.5cm) during mid April 1991 in Kibbutz Ein-Hahoreh, Israel. Drip irrigation (385m³ water per 1000m²) and other standard agronomic practices were employed including insecticides sprays against moths and aphids (combination of Thionex 350g/1000m³ + Supracide 250g/1000m³ on 21th June 1991 and Monocron 200g/1000m³ on 6th September 1991). The plots were sprayed twice by BIC+VO emulsions (on 8th and 14th August 1991) at 70 liter/1000m³ rate using portable mist blower.

35 Prior to the commercial harvest (6th October 1991), 25 bolls were sampled from the inner rows of each replicate and weighed and ginned. Lint quality was assessed by standard tests in the laboratories of the Cotton Production and Marketing Board Ltd., Herzellia, Israel. Foliar injuries assessed visually as described in Example 2.

40 No phytotoxic symptoms or significant changes in agronomic traits were found on plots treated with BIC+VO formulations compared to the control plots; plots treated with BIC alone suffered heavy foliar damage.

Chemical ¹	Oil ²	Injury Index	Boll Size (gr.)	Lint %	Sugars %	Homogeneity
Control		0	7.8	40.3	0.032	85.0
(-)	Cottonseed oil	0	7.0	39.8	0.026	86.2
BP	(-)	4	(-)	(-)	(-)	(-)
BP	Cottonseed oil	0	7.0	39.9	0.024	86.2
CAL	Cottonseed oil	0	7.5	40.0	0.036	85.9
LAL	Cottonseed oil	0	7.7	40.7	0.027	85.0
Control		0				
(-)	Soybean oil	0				
BP	(-)	4				
BP	Soybean oil	0				
CAL	Soybean oil	0				
LAL	Soybean oil	0				

1 1% wt/wt aqueous emulsion of BP = dibutyl phthalate, CAL = cetyl alcohol, LAL = lauryl alcohol.

2 Oil concentration = 3%.

Biological Examples: BIOACTIVITY TESTS:

Example 4.

Tobacco Whitefly adults response to various BIC: Tobacco Whitefly, (TWF, *Bemisia tabaci*) was reared on cotton seedlings in green house. Female whiteflies were caught with aspirator equipped with contraption, and transfer to clip-on leaf cage (transparent cylinder, base diameter 2cm, height 7cm).

The leaf cages, each containing twenty females, were attached to lower side of leaves of pre-treated cotton seedlings. The cotton seedlings had been sprayed to runoff with BIC and BIC + VO and held under controlled conditions for various aging intervals.

TWF settling and mortality were recorded after exposures of 1.5, 5, and 24 hr. Mortality results were corrected according to Abbott's formula [W.S. Abbott, J. Econ Entomol. 18:265-267 (1925)]; settling deterrence was expressed as Settling Ratio (SR = [T/C], where T & C are the percentage of adults settled on treatment and control respectively after t hours of exposure). All experiments replicated 9-12 times.

A strong settling deterrence followed by death of TWF-adults were observed for the various BIC types. The activity of all combinations were stronger than those of each component separately (in several cases activity of BIC alone could not be measured due to severe leaf injuries).

	Chemical ¹ (% wt/wt)	Settling Ratio (%) After the ² 4 hr. 24 hrs.		Mortality (%) After the ² 4 hrs. 24 hrs.		Plant Injury Index ³
5		<u>Oil alone</u>				
	CO	20	62	0	37	0
	CO (4%)	18	62	0	43	0
10		<u>Aromatic esters</u>				
	BP	(-)	(-)	(-)	(-)	4
	BP + CO	0	0	39	99	
	BNBN	(-)	(-)	(-)	(-)	4
15	BNBN + CO	0	0	27	100	
		<u>Aliphatic esters</u>				
	BS	123	100	0	0	1
	BS + CO	0	7	4	61	0
20		<u>Carboxylic acids</u>				
	MAC	31	83	0	3	0
	MAC + CO	0	12	3	56	0
	MAC+CAL + CO	1	2	12	72	0
25		<u>Fatty alcohols</u>				
	CAL	76	98	0	0	0
	CAL + CO	12	29	5	65	0
	OAL + CO	2	10	0	86	0
30		<u>Terpenoids</u>				
	TER. MIX.	(-)	(-)	(-)	(-)	4
	TER. MIX. + CO	15	17	26	76	0
	Camphene	125	100			0
	Camphene + CO	58	42	6	31	0
35	Camphor + CO	9	20	(-)	75	0
		<u>Miscellaneous</u>				
	ETH	83	97	0	0	4
	ETH + CO	6	31	0	48	2
40						

1 Aqueous emulsions of BNBN = benzyl benzoate, BP = dibutyl phthalate, BS = dibutyl sebacate, CAL = cetyl alcohol, CO = cottonseed oil, ETH = 2-Ethyl-1,3-hexanediol, LAL = lauryl alcohol, MAC = myristic Acid, MAC+CAL (0.5% of each), OAL = Oleyl alcohol, TER. MIX. = terpenoid mixture consists of Phytol (0.5%) + Linalool (0.25%) + Geraniol (1%) + Carvone (0.25%), CO concn. = 3% and BIC concn. = 1% wt/wt, formulated with no co-solvent, if not specified otherwise.

2 Three days post spray to cotton seedlings.

3 A rating of 0, 1, 2, 3, 4 indicated <1%, 1-10%, 11-25%, 26-50%, > 50% an average leaf damage.

Example 4: CONTINUED

(Response of Tobacco Whitefly adults to various BIC)					
CHEMICALS¹ (%wt/wt)	SETTLING RATIO (%) AFTER²		MORTALITY (%) AFTER²		PLANT INJURY INDEX³
	4h	24h	4h	24h	
Carboxylic acids					
CIA	100	93	0.5	2.8%	0
CIA	1.6	2.6	6.0	94	0
MALE + (X)	34.8	8.3	34.4	86.6	0
MALI + CO	0	0.3	27	98.5	0
SUCC + CO	34.8	8.6	7.8	62.3	0

1 CIA = citric acid, MALE = Maleic acid, MALI = malic acid, SUCC = succinic acid, CO = cottonseed oil, CO concn. = 3% and BIC concn. = 1% wt/wt, formulated with no cosolvent, if not specified otherwise.

2 Three days post spray to cotton seedlings.

3 A rating of 0, 1, 2, 3, 4 indicated <1%, 1-10%, 10-25%, 25-50%, >50% an average leaf damage.

Example 5.

TWF adults response to dibutyl phthalate in combination with various vegetable oils (VO): performed as described in example 3.

The four vegetable oil + dibutyl phthalate combinations showed a very strong and persistent deterrence followed by death of TWF adults:

Days Post-Spray	Oil type	Settling Ratio ² (%)		Mortality (%)	
		Oil alone	Oil + BP	Oil alone	Oil + BP
2	Cottonseed	1.1	0.0	69	99
	Soybean	2.0	0.0	91	100
	Rapeseed	2.3	0.0	72	100
	Castor	5.9	0.0	91	100
7	Cottonseed	85	7.3	15	75
	Soybean	90	12.3	6.8	69
	Rapeseed	0.0	0.0	83	100
	Castor	5.5	0.0	72	99
17	Cottonseed	84	7.0	0.9	37
	Soybean	90	12.0	0.0	56
	Rapeseed	5.3	0.0	54	98
	Castor	9.1	0.0	44	95

1 Aqueous emulsions of 3% oil and of 3% oil + 1% dibutyl phthalate.

2. SR = (T/C), where T & C are the percentage of adults settled on treatment and control respectively.

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Example 6.

Responses of development stages of TWF to various BIC:

5 Cotton seedlings sprayed with BIC combinations and with cottonseed oil and were held indoors (25 °C). A week postspray, leaf cages, each containing twenty females, were attached to lower leaf side for 24 hours. The number of eggs laid was counted under binocular microscope and compared with the control. The nymphs developing from the eggs, until the pupal stage, were counted 15-17 days after oviposition.

10 Seven-days old residues of CAI + CO and LAI + CO were active against developmental stages, whereas BP + CO residue was still active primarily against adults.

Chemicals ¹	Mortality of Adults (%)	No. Eggs per Female	Relative No. Eggs per Female	Relative No. Pupae per Female	Relative No. Pupa Per Eggs
Control	0	5.6	100	100	100
CO (4%)	15	4.2	75	39	52
BP + CO	91	0	0	0	0
CAI + CO	15	2.5	45	7	16
LAI + CO	4	4.7	75	15	20

1 Aqueous emulsions of CO = cottonseed oil, BP = dibutyl phthalate, CAI = catyl alcohol, LAI - lauryl alcohol, Concentrations (% wt/wt) were CO = 3%, BIC = 1%, when not specified otherwise.

25 Example 6: CONTINUED. (Responses of development stages of TWF to various BIC)

CHEMICALS ¹	MORTALITY OF ADULTS (%)	NO. EGGS PER FEMALE	RELATIVE NO. EGGS PER FEMALE (Con = 100%)	RELATIVE NO. PUPAE PER FEMALE (Con = 100%)	RELATIVE NO. PUPA PER EGGS (Con = 100%)
Non-treated	0	4.7	100	100	100
CO (4%)	15	3.5	75	39	100
CIA	0	5.3	114	116	103
CIA + CO	90	0.2	4.5	3.3	
MALE + CO	87	0.1	3.0	0.6	20
SUCC + CO	62	0.2	6.0	6.0	100
MMYR	0	5.7	122	89	73
MMYR + CO	2	3.7	79	31	39

1 Aqueous emulsions of CO = cottonseed oil, CIA = Citric acid, MALE = Maleic z acid, SUCC = succinic acid, MMYR = methyl myristate. Concentrations (% wt/wt) were CO = 3% , BIC = 1%, when not specified otherwise.

Responses of development stages of TWF to direct spray of various BIC

50 Cotton seedlings infested with a developmental stages of TWF were sprayed to runoff, after counting the eggs or the larvae presented. The plants were held under controlled conditions and the fraction of an immature stage developed into adults were measured and compared to that of the untreated control. The spray toxicity of BIC + OIL against various developmental stages of TWF is demonstrated in the following example.

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Chemicals ¹	% Survival of whitefly after direct spray of the indicated immature stage				
	Egg	L1	L2	L3	L4(P)
CO (4%)	87	3.60	1.90	4.65	9.09
LAL + CO	49	0.00	0.28	0.00	0.74
CAL + CO	59	1.33	9.30	12.90	66.7
SAL + CO	93	0.74	0.27	0.22	13.0
OAL + CO	56	0.00	1.15	0.24	0.18

1 Aqueous emulsions of: CO = cottonseed oil, LAL = lauryl alcohol, CAL = cetyl alcohol, SAL = stearyl alcohol, OAL = Oleyl alcohol. Concentrations (%wt/wt) were CO = 3%, BIC = 1%, when not specified otherwise

2 L1 = 1st instar nymph, L2 = 2nd instar nymph, L3 = 3rd instar nymph, L4 = 4th instar nymph (pupa)

3 Survival = ratio of fractions of: treated to untreated immature stage developed into adults

Example 7.

Test of Dibutyl phthalate + VO combination as protectant against non-persistent virus transmitted by Aphids (*Myzus persicae*): Healthy cucumber seedlings (Beit Alfa) which served as a test plants were sprayed to runoff with BIC+VO combinations and allowed to dry, 1%-Virol spray was used as standard treatment. The control leaves were sprayed with surfactant solution. Aphid adults apterae (*Myzus persicae*), starved for 2 hours, were allowed 3 minutes access to untreated infected cucumber which served as a source for the non-persistent Zucchini Yellow Mosaic Virus (ZYMV). The aphids were subsequently confined for 24 hours on test plants by placing a tube around each test plant, and the survivors were killed. The test seedlings were allowed to grow until no more plants developed symptoms.

BIC+VO combination prevented completely the plant disease transmission, whereas VO emulsions and the standard mineral oil (Virol) sprays were less effective.

Oil type	Transmission (%)		Relative Transmission (%) (control = 100%)	
	Oil alone	Oil + BP	Oil alone	Oil + BP
Cottonseed	24	0.0	40	0.0
Soybean	33	0.0	55	0.0
Virol ¹	36	(-)	60	(-)
Control	60	(-)	100	(-)

1 1% - mineral oil applied as an aqueous emulsion (a standard treatment).

Example 8.

Control of TWF under field conditions: commercial cotton (H-23) was sown in regular row width (96.5 cm) during mid April 1991 in Kibbutz Ein-Hahoreh, Israel. Drip irrigation (385m³ water per 1000m²) and other standard agronomic practices except sprays against *Bemisia tabaci* were employed.

Experimental plots were arranged in a randomized complete-block design with four replications per treatment. Each plot consisted of four rows X 12m long with untreated plots separating replicates. The plots were sprayed twice by BIC+VO emulsions (on 8th and 14th August 1991) at 70 liter/1000m³ rate using portable mist blower. Leaves samples consisted of 10 leaves per replicate were collected the fifth node from the top of the main stem, twice a week started on 14th August 1991. Number of all living larvae and pupae (neonate excluded) on each sampled leaf was determined by the aid of magnifying glass (x10).

The ability of the three types of BIC+VO combinations to control field population of TWF is demonstrated in Fig. 1.

Fig. 1

Claims

1. A non-toxic arthropod control composition applied to foliage for plant protection comprising a Behavior-Interfering Compound(s), agricultural oil and/or surface active compounds and diluents.
2. An arthropod control composition according to claim 1 wherein the Behavior-Interfering Compound is any known conventional compound that can interrupt or alter the normal behavioral sequences of the target.
3. An arthropod control composition according to claim 2 wherein the Behavior-Interfering Compound is a repellent or deterrent agents, hyperactivity inducer or irritant, narcotic, knock-down agent, physical barrier agent or physical poison.
4. An arthropod control composition according to claim 3 wherein the Behavior-Interfering Compound is selected from general purpose arthropod repellent, C10-C22 alcohols, C10-C22 carbonyl compounds C10-C22 carboxylic acids and terpenoids, polybasic carboxylic acids, substituted mono and polybasic carboxylic acids, esters of the mentioned carboxylic acids.
5. An arthropod control composition according to claim 3 and 4 wherein the Behavior-Interfering Compound is selected from: methyl-nonyl keton, N-butyl acetanilide, N,N-diethyl-3-methylbenzimidazole (DEET), dibutyl phthalate, dimethyl phthalate, dibutyl succinate, dibutyl adipate, butopyronoxyl (indalone), butoxypoly(propylene glycol), benzyl benzoate, 2-ethyl-1,3-hexanediol, 2-butyl-2-ethyl-1,3-propanediol, 2-hydroxyethyl n-octyl sulfide, citronellal, camphor, camphene, terpinen-4-ol, isoborneol, borneol, isobornyl acetate, bornyl acetate, phytol, β -farnesene, lauryl alcohol, cetyl alcohol, oleyl alcohol, myristic acid, stearic acid, farnesol, geraniol, citral, terpineol, beta-farnesene, p-cymene, ocimene, limonene, thymol, pinene, myristyl alcohol, stearyl alcohol, oxalic acid, fumaric acid, succinic acid, adipic acid, sebacic acid, malic acid, fumaric acid, maleic acid, tartaric acid, citric acid, aconitic acid, aconitic acid, lactic acid, oleic acid, sorbic acid, myristate esters, diethyl phthalate.
6. An arthropod control composition according to claim 1 wherein the agricultural oil is a vegetable oil.
7. An arthropod control composition according to claim 6 wherein the vegetable oils is selected from cottonseed oil, soybean oil, rapeseed oil, castor oil, sunflower oil, groundnut oil, palm oil, safflower oil, coconut oil, sesame oil, corn oil, linseed oil, tung oil and palm kernel oil.
8. An arthropod control composition according to claim 1 wherein the diluent is water or an appropriate organic solvent.
9. An arthropod control composition according to claim 1 for the protection of plants against sucking arthropods.
10. An arthropod control composition according to claim 6 wherein said target pests are whiteflies (Aleurodidea) and aphids (Aphidoidea) and soft-bodied organisms such as mites, hoppers, mealy bugs and thrips.
11. A method for protection of plants against arthropod comprising application or spraying of the arthropod control composition defined in claim 1 to foliage.

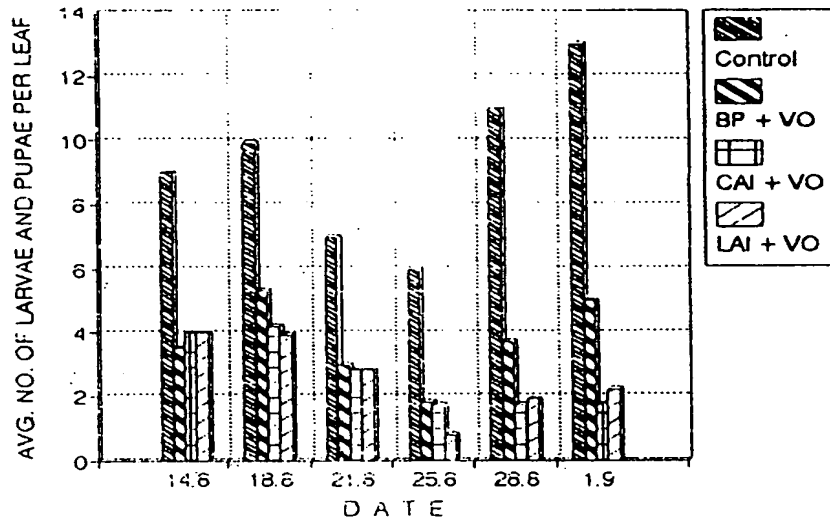


Fig 1. Effect of BIC + VO on field population of TWF (VO=3% cottonseed oil, BP= 1% dibutyl pthalate, CAI=1% cetyl alc., LAI=1% lauryl alc.)



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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 3148

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 November 1993	Examiner Lamers, W
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